DOCUMENT RESUME

ED 338 361 PS 019 910

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TITLE The Relationship among Temperament, Illness, and Salivary Cortisol in Daycare Children.
SPONS AGENCY Health Resources and Services Administration (DHHS/PHS), Rockville, MD. Office for Maternal and Child Health Services.
PUB DATE Apr 91
CONTRACT MJC-420565
NOTE 11p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (Seattle, WA, April 18-20, 1991).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Child Health; *Day Care Centers; *Personality; *Preschool Children; Preschool Education; *Stress Variables
IDENTIFIERS Child Behavior; *Childhood Illnesses; Respiratory Diseases; *Salivary Cortisol

ABSTRACT

This study examined the relationships among cortisol level and reactivity, illness, and behavioral measures in 21 day care children between 22 and 48 months of age. Children's temperament was measured by means of the Toddler Behavior Assessment Questionnaire (TBAQ) and the Goodfit Questionnaire, which were completed by parents and teachers. Over several weeks, children were screened for illness by a physician and a nurse and were diagnosed weekly. Salivary cortisol levels were measured both before and after children were presented with a mildly stressful task. Results for the cortisol measures indicated that: (1) baseline cortisol level was negatively correlated with teachers' Goodfit ratings of cheerfulness and sociability; and (2) cortisol level after the stressful task was correlated with parents' Goodfit rating of fussiness, and negatively correlated with teachers' Goodfit rating of cheerfulness. Results for the illness diagnoses indicated that: (1) withdrawal in the stressful task was correlated with respiratory infection, and negatively correlated with otitis media; (2) respiratory infection and overall illness were negatively correlated with the TBAQ rating of interest; (3) respiratory infection was correlated with teachers' Goodfit ratio of even-temperedness; and (4) respiratory infection and overall illness were correlated with parents' Goodfit rating of whinyness, but negatively correlated with teachers' rating. (BC)

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THE RELATIONSHIP AMONG TEMPERAMENT, ILLNESS, AND SALIVARY CORTISOL IN DAYCARE CHILDREN

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POSTER PRESENTED AT THE BIENNIAL MEETINGS OF THE SOCIETY FOR RESEARCH IN CHILD DEVELOPMENT, SEATTLE, WASHINGTON, APRIL 1991. THIS RESEARCH WAS SUPPORTED IN PART BY GRANT MJC-420565 FROM THE MATERNAL AND CHILD HEALTH BUREAU (TITLE V, SOCIAL SECURITY ACT), HEALTH RESOURCES AND SERVICES ADMINISTRATION, DEPARTMENT OF HEALTH AND HUMAN SERVICES TO LYNNE V. FEAGANS AND INGRID BLOOD, PRINCIPAL INVESTIGATORS.

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INTRODUCTION

While stress and its psychological and biological correlates have been studied in adults, only recently has this relationship been examined in the study of children and their development. This paucity of information reflects the difficulty in assessing stress in children, both behaviorally and biologically.

Humans and other animals, particularly primates, have consistently shown individual differences in heightened reactivity to novel, challenging and stressful situations (Gunnar, 1987; Suomi, 1984, 1987). Biological measures have also shown consistent individual differences, including cortisol measures (Suomi, 1987; Susman et al., 1987).

Explanations for this reactivity include genetic factors (Plomin & Stocker, 1988), temperament (Thomas, Chess, & Korn, 1982), and low threshold of responsivity (Kagan, Reznick, & Snidman, 1987). While there is disagreement regarding the basis for heightened reactivity, there is consensus regarding its potential for increasing vulnerability to stress (Suomi, 1987).

Heightened cortisol has also been linked to adverse physical health. This relationship is postulated to occur because the activation of the pituitary-adrenocortical system suppresses the immune system. This has been thought to lead to disease (Arthur, 1987; Selye, 1976; Solomon, Amkraut, & Rubin, 1985). However, no studies exist exploring such a link between biological reactivity and minor illness in children.

Stress and the Neuroendocrine Response

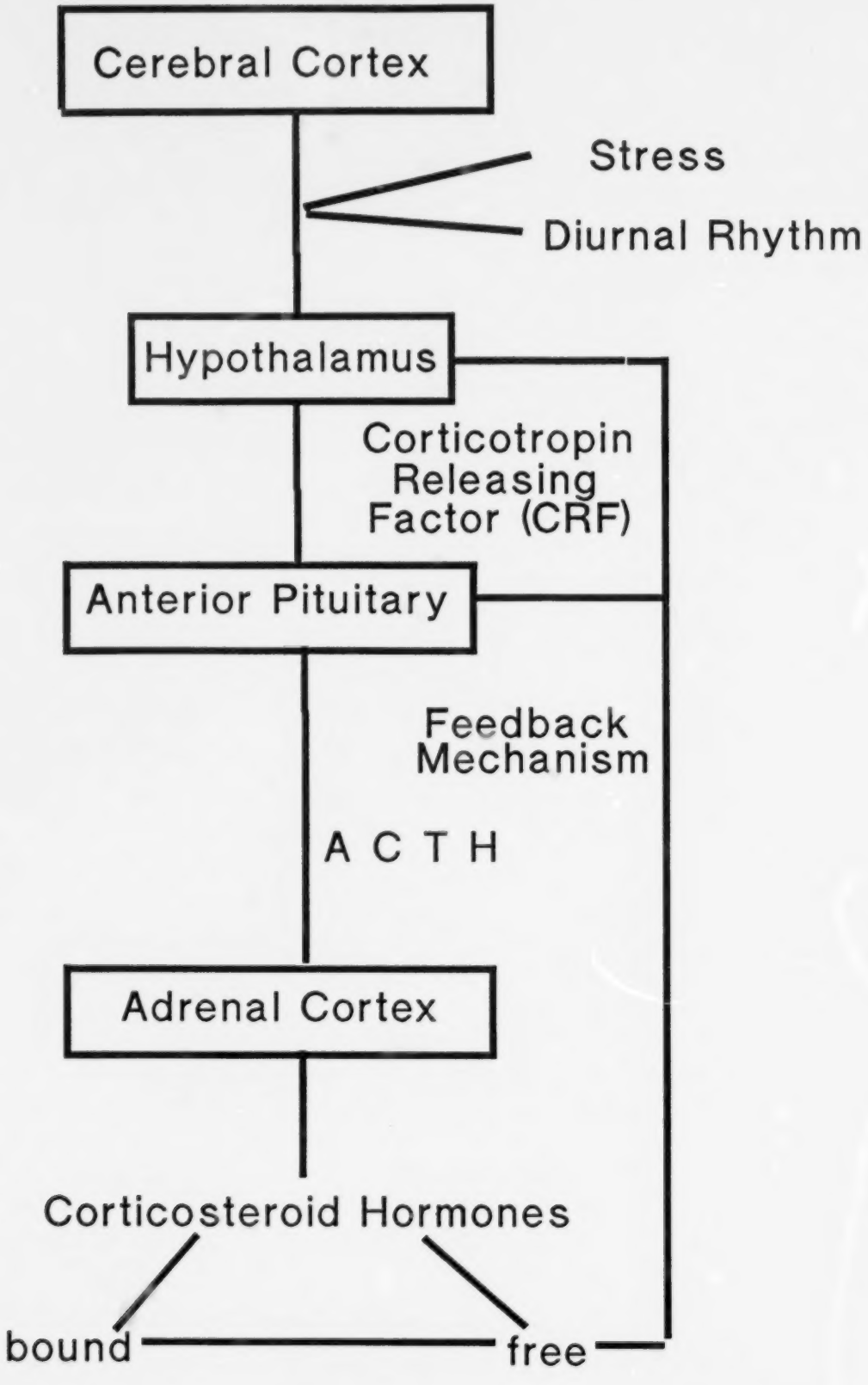
The physiological response to stress is a complex one. The responses to a stressor are designed to be adaptive, to maintain homeostasis of the body's environment. These response processes operate in complex and integrative ways using feedback mechanisms to regulate hormone levels in order to maintain the homeostatic conditions necessary for survival.

With the activation of the stress response, behaviors noting vigilance are evident and include pupil dilation, central nervous system (CNS) arousal and alertness, increased skeletal and cardiac muscle contraction, increased respiration, and decreased feeding and reproductive behavior. The CNS sets into motion the stress axes which include the hypothalamic-pituitary-adrenal (HPA) axis. First, the hypothalamus releases corticotropin releasing hormone (CRH). Next the anterior pituitary responds by releasing adrenocorticotropic hormone (ACTH) that stimulates the adrenal cortex to release cortisol and adrenal androgens. (See diagram of the HPA axis).

Cortisol as a Measure of Stress

Cortisol plays a vital role in the stress response. Cortisol is the primary glucocorticoid produced by the adrenal cortex, a portion of the adrenal glands. Glucocorticoids are corticoids (steroid hormones produced by the adrenal cortex) that tend to increase blood glucose levels. Cortisol is responsible for a wide variety of physiological actions influencing metabolism, body water distribution, electrolyte balance, and blood pressure regulation (Arthur, 1987; Levine, 1984; University of Minnesota Hospital, 1987). Cortisol also has anit-inflammatory and immuno-suppressing actions.

DIAGRAM OF THE HYPOTHALAMIC-PITUITARY-ADRENAL AXIS



HYPOTHESES

SINCE HEIGHTENED REACTIVITY HAS BEEN LINKED TO A NUMBER OF IMPORTANT OUTCOMES AND BECAUSE OF THE IMPORTANCE OF THIS HEIGHTENED REACTIVITY IN NOVEL OR STRESSFUL SITUATIONS TO BIOLOGICAL FUNCTIONING AND THE SUGGESTED LINKS BETWEEN TEMPERAMENT, ILLNESS AND THIS REACTIVITY, THIS STUDY WILL EXPLORE THESE RELATIONSHIPS IN DAYCARE-ATTENDING CHILDREN.

HYPOTHESIS 1: IT IS HYPOTHESIZED THAT CHILDREN WHO ARE ILL MORE OFTEN WILL HAVE HIGHER BASELINE LEVELS OF CORTISOL AND WILL DISPLAY MORE NEGATIVE REACTIVE BEHAVIORAL STYLES IN A "CHALLENGE" SITUATION.

HYPOTHESIS 2: CHILDREN WITH TEMPERAMENTS WHICH REFLECT A MORE NEGATIVE REACTIVE STYLE (FEARFUL, INHIBITED) INHERENTLY MAY ALSO BE AT RISK FOR HIGH CORTISOL LEVELS AS WELL AS GREATER CHANGES IN CORTISOL AS A RESULT OF BEING IN A "CHALLENGE" SITUATION.

SUBJECTS

SUBJECTS ARE 21 CAUCASIAN CHILDREN WITH NO DEVELOPMENTAL DISABILITIES BETWEEN THE AGES OF 22-48 MONTHS ATTENDING ONE OF THREE DAYCARE SITES IN CENTRAL PENNSYLVANIA. THESE SUBJECTS WERE DRAWN FROM AN ONGOING PROSPECTIVE STUDY OF HEALTH IN DAYCARE DIRECTED BY DR. LYNNE FEAGANS.

DEMOGRAPHIC INFORMATION

OCCUPATION

FATHERS

PROFESSIONAL/SEMIPROFESSIONAL	55%
SKILLED/SEMI-SKILLED	40%
UNSKILLED	5%

MOTHERS

PROFESSIONAL/SEMI-PROFESSIONAL	52%
SKILLED/SEMI-SKILLED	43%
UNSKILLED/OTHER	5%

INCOME

MEAN - $46,760 RANGE - $7,200-$95,000

AGE

AVERAGE AGE OF FATHERS	34 YEARS
AVERAGE AGE OF MOTHERS	31 YEARS
AVERAGE AGE OF CHILDREN	33 MONTHS

PROCEDURES

Temperament was measured by the Toddler Behavior Assessment Questionnaire (Goldsmith, 1987) and the Goodfit Questionnaire (Feagans, 1988) completed by both parents and daycare teachers. Weekly, children were screened by a physician and a nurse for signs of illness. A weekly diagnosis was then made. From this data proportions of the diagnoses were calculated. Children in this study were ill on average over 50% of the time. (See diagram of Incidence of Illnesses).

To determine cortisol levels and reactivity, three saliva samples were obtained for each subject: baseline, pre-stress, and post-stress. The baseline measure was collected in the daycare using a plastic pipette and Kool-Aid to stimulate saliva production. The pre-stress measure was collected in the classroom immediately before the "challenge" situation in which the child was taken to an unfamiliar room in the daycare and presented with a mildly stressful age-appropriate task. The child was presented with small, age-appropriate toys with which s/he was allowed to play. The toys were then sealed in clear plastic cylinders. The child could not play with the toys until s/he could open the containers. The entire situation lasted 15-20 minutes, after which a post-stress saliva sample was taken and the child returned to the daycare.

Measures derived from the saliva include average level of cortisol as well as change in cortisol level from the challenge situation. Cortisol was determined through standard radioimmunoassay of unbound cortisol in saliva. Additional measures obtained from the challenge situation include level of frustration as the child attempts to open the containers and initial ratings of inhibition using a modification of Kagan et al.'s (1987) rating system.

CORTISOL RESULTS

DEMOGRAPHIC VARIABLES BASELINE AND POST-STRESS CORTISOL LEVELS WERE CORRELATED WITH DEMOGRAPHIC VARIABLES. NO CONSISTENTLY SIGNIFICANT RESULTS WERE FOUND.

EYECOLOR EYECOLOR WAS SIGNIFICANTLY NEGATIVELY CORRELATED WITH POST-STRESS CORTISOL LEVEL, BUT NOT WITH BASELINE LEVEL. CHILDREN WITH BLUE EYES HAD HIGHER POST-STRESS CORTISOL LEVELS THAN THOSE WITH BROWN OR GREEN EYES. HOWEVER, THIS BLUE-EYED GROUP IS EXTREMELY SMALL.

ILLNESS VARIABLES BASELINE AND POST-STRESS CORTISOL LEVELS WERE NOT SIGINIFICANTLY CORRELATED WITH ANY CATEGORY OF ILLNESS.

BEHAVIORAL RATINGS BASELINE AND POST-STRESS CORTISOL LEVELS WERE NOT SIGNIFICANTLY CORRELATED WITH BEHAVIORAL RATINGS IN THE CHALLENGE SITUATION.

TODDLER BEHAVIOR ASSESSMENT QUESTIONNAIRE BASELINE AND POST-STRESS CORTISOL LEVELS WERE NOT SIGNIFICANTLY CORRELATED WITH EITHER PARENTS OR DAYCARE WORKERS RATINGS ON THE FIVE DIMENSIONS OF THE TBAQ TEMPERAMENT MEASURE.

GOODFIT QUESTIONNAIRE SEVEN VARIABLES WERE OF MOST INTEREST: CHEERFUL, EVEN-TEMPERED, CALM/EASY-GOING, SOCIABLE WHINY/FUSSY, SHY/RESERVED, AND COLD/INDIFFERENT. BASELINE CORTISOL WAS SIGNIFICANTLY NEGATIVELY CORRELATED WITH DAYCARE RATINGS OF CHEERFULNESS AND SOCIABILITY, BUT NOT SIGNIFICANTLY CORRELATED WITH PARENTS' RATINGS ON ANY OF THESE VARIABLES. POST-STRESS CORTISOL WAS SIGNIFICANTLY NEGATIVELY CORRELATED WITH DAYCARE RATINGS OF CHEERFULNESS AND POSITIVELY CORRELATED WITH PARENTS' RATINGS OF WHINY/FUSSINESS.

ILLNESS RESULTS

DEMOGRAPHIC VARIABLES DEMOGRAPHIC VARIABLES WERE NOT SIGNIFICANTLY CORRELATED WITH ANY CATEGORY OF ILLNESS.

EYECOLOR EYECOLOR WAS NOT SIGNIFICANTLY CORRELATED WITH ANY CATEGORY OF ILLNESS.

BEHAVIORAL RATINGS RATINGS OF WITHDRAWAL IN THE CHALLENGE SITUATION WERE SIGNIFICANTLY POSITIVELY CORRELATED WITH THE PROPORTION OF UPPER RESPIRATORY INFECTIONS, BUT NEGATIVELY CORRELATED WITH THE PROPORTION OF OTITIS MEDIA. INHIBITION OF VOCALIZATION APPROACHED SIGNIFICANCE WITH PROPORTION OF UPPER RESPIRATORY INFECTIONS.

TODDLER BEHAVIOR ASSESSMENT QUESTIONNAIRE PROPORTION OF UPPER RESPIRATORY INFECTIONS WAS SIGNIFICANTLY NEGATIVELY CORRELATED WITH DAYCARE RATINGS OF INTEREST AND TENDENCY TO EXPRESS PLEASURE. PROPORTION OF OVERALL ILLNESS WAS HIGHLY NEGATIVELY CORRELATED WITH DAYCARE RATINGS OF INTEREST AND POSITIVELY CORRELATED WITH PARENT'S RATINGS OF INTEREST.

GOODFIT QUESTIONNAIRE PROPORTION OF UPPER RESPIRATORY INFECTIONS WAS SIGNIFICANTLY POSITIVELY CORRELATED WITH DAYCARE RATINGS OF EVEN-TEMPEREDNESS. PROPORTION OF OTITIS MEDIA WAS NEGATIVELY CORRELATED WITH PARENTS' RATINGS OF SOCIABILITY AND COLDNESS/INDIFFERENCE. PARENTS' RATINGS OF WHINYNESS WERE POSITIVELY CORRELATED WITH PROPORTION OF OVERALL ILLNESS AND UPPER RESPIRATORY INFECTIONS. HOWEVER, DAYCARE RATINGS OF WHINYNESS WERE NEGATIVELY CORRELATED WITH PROPORTION OF OVERALL ILLNESS AND PROPORTION OF UPPER RESPIRATORY INFECTIONS.

DISCUSSION

There are several possible explanations for the findings presented here. This study is exploratory, and thus several factors may contribute to the mixed nature of the results. First, the challenge situation may not have stressed the children enough physiologically. While there was good variability in the behavioral ratings of the situation, most children did not experience a significant increase in post-stress cortisol. More studies are needed to determine in what situations and under what conditions children will experience an increase in cortisol level.

Second, the small sample size of this study limits its predictive power. Given that some of the correlations were high although non-significant, larger sample sizes would allow for stronger conclusions to be drawn about the nature of the hypothesized relationships among temperament, illness, and salivary cortisol in daycare children.

Third, due to the nature of the saliva samples and cortisol assays, these samples may not be as reliable as would be desirable. For this study, only baseline and post-stress cortisol measures were analyzed. Perhaps more samples across multiple situations would grant additional insight into the aforementioned relationships.

Lastly, for neither of the two highly reliable and valid measures of temperament chosen did daycare and parent ratings correlate with one another. Neither did they correlate with the behavioral ratings in the challenge situation. It is possible that the parental ratings reflect a temperamental trait and the daycare ratings reflect a temperamental state. The behavioral ratings appear to be situation-specific and thus poorer predictors of illness and cortisol reactivity.